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REPORTS

ON

PUBLIC HEALTH AND MEDICAL SUBJECTS.

No. 12.

DR. W. V. SHAW'S REPORT TO THE MINISTRY OF HEALTH ON AN EPIDEMIC OF ENTERIC FEVER AT BOLTON-UPON-DEARNE.

MINISTRY OF HEALTH.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.
1922.

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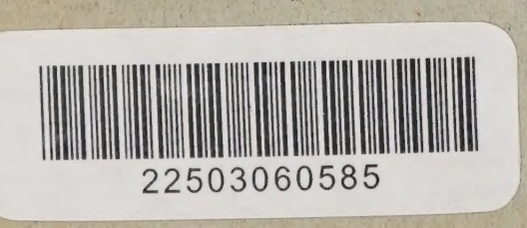
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To the Right Hon. Sir ALFRED MOND, Bt., M.P.,
Minister of Health.

SIR,

I HAVE the honour to present the following Report by Dr. W. V. Shaw, one of the Medical Officers of the Ministry, on the occurrence of Enteric Fever in the Bolton-upon-Dearne Urban District and adjoining sanitary districts in the West Riding of Yorkshire in 1921. I agree with the findings of the Report, which have also been concurred in by Dr. Reece, the Senior Medical Officer of the Section of the Ministry concerned in these matters.

The account given by Dr. Shaw repeats the lesson, taught by previous typhoid epidemics, of the necessity of taking every precaution to prevent pollution in any form or degree of the gathering grounds of water supplies; and if this is not possible, to treat the water in such manner that no undue risk shall attend its consumption. It illustrates further the well-known fact that the water of a village pump, liable to pollution from its surroundings, may be used by a community without any manifest disadvantage until it becomes contaminated, through one channel or another, with specific infection present in the population of the neighbourhood. When this occurs local disaster may follow.

While this country has just cause to be proud of the general excellence of its water supplies, this outbreak of widespread and fatal illness following the accidental contamination of a public water supply warns us against being lulled into a false sense of security. For quite apart from the occurrence of Typhoid or other endemic disease transmissible by drinking water, Cholera has, at the present time, assumed epidemic proportions in Russia and in Poland, and the possible introduction of the infection of this disease into England is a fact that has to be realised. It therefore behoves all public authorities who are responsible for our water undertakings to use every endeavour to ensure the purity and safety of their supplies.

I have the honour to be,
Sir,
Your obedient Servant,
GEORGE NEWMAN

Whitehall,
April, 1922.

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Dr. W. V. SHAW'S REPORT TO THE MINISTRY OF HEALTH ON AN EPIDEMIC OF ENTERIC FEVER IN THE BOLTON-UPON-DEARNE AND THE DARFIELD URBAN DISTRICTS, AND IN THE ADJACENT PARISHES OF BILLINGLEY IN THE BARNSLEY RURAL DISTRICT AND GREAT AND LITTLE HOUGHTON IN THE HEMSWORTH RURAL DISTRICT IN 1921.

REASONS FOR THE INQUIRY.

During the four weeks ended the 20th August, 1921, 21 cases of Enteric Fever were notified to the Medical Officer of Health of Bolton-upon-Dearne Urban District. There had also been considerable prevalence of ill-defined illness characterised by symptoms of vomiting and diarrhœa, and on 23rd August I received instructions to proceed forthwith to Bolton-upon-Dearne and make inquiry concerning the circumstances associated with the outbreak. I commenced the inquiry on 24th August, and re-visited the district from time to time until the 20th December, 1921.

TOPOGRAPHICAL DISTRIBUTION OF THE ILLNESS AND THE EXTENT AND SCOPE OF THE EPIDEMIC.

At Bolton-upon-Dearne I found that the persons attacked by Enteric Fever included both males and females of ages ranging from under 14 years to 55 years. Some of the patients were school children and others were occupied in coal mining, household duties, &c. They lived in 21 houses scattered through 14 streets in different parts of the district; 14 had sickened with the disease between 20th–31st July, and from 1st–12th August 9 others were attacked. I learnt that simultaneously with the cases at Bolton-upon-Dearne other cases of Enteric Fever had been notified, four in the adjacent Urban District of

Darfield, and four in the adjoining parishes of Great and Little Houghton in the Hemsworth Rural District and one in the parish of Billingley in the Barnsley Rural District. My inquiry was therefore extended to these districts. The population of the districts involved exceeds 20,000 and the area is approximately 12 square miles. Altogether from 17th July to 24th December there occurred in the Bolton-upon-Dearne Urban District 351 cases of Enteric Fever with 37 deaths *; in the Darfield Urban District, 33 cases and 5 deaths; in the parish of Great Houghton, 11 cases (none fatal); and one (non-fatal) case in each of the parishes of Little Houghton and Billingley.

The districts concerned are situated towards the south of the West Riding of Yorkshire on the coal measures and the greater part of them is undermined by collieries. Their relative position will be seen on the accompanying map. Bolton-upon-Dearne Urban District lies to the north of the River Dearne, which forms its southern and part of its western boundary; the parish of Billingley adjoins it on the north-west. The parishes of Great and Little Houghton abut on the northern boundary of the parish of Billingley, Little Houghton lying to the west of Great Houghton. To the west of these three parishes is the Urban District of Darfield. In the Bolton-upon-Dearne Urban District the population is grouped in three villages—Bolton-upon-Dearne to the south and Highgate and Goldthorpe to the north-west and north-east respectively. The population of these two latter villages now exceeds that of Bolton-upon-Dearne village. In the Darfield Urban District the greater number of the inhabitants live in the village of Darfield situated to the south-east of the District; in the parish of Great Houghton the population is collected in the villages of Great Houghton and Sandhill, and in Little Houghton and Billingley in villages bearing their names.

The population of the districts is mainly engaged in coal mining and in industries connected therewith.

Geology of the Districts.—The superficial strata are alluvium, sand and rock. At Bolton-upon-Dearne the rock is the upper bed of the Chevet Sandstone which varies in thickness from 12–40 feet and is extensively fissured. Beneath this is a bed of marl and blue clay overlying the Oaks Rock which forms the bed of the River Dearne as far as Adwick at the extreme south-east corner of the Bolton-upon-Dearne Urban District. To the north of Bolton-upon-Dearne village the superficial strata vary. At Highgate there is friable sandstone from one to 10 feet in thickness overlying marl and clay. Eastwards at Goldthorpe there is magnesian limestone of the Permian period. Westwards of Bolton-upon-Dearne Urban District the superficial strata are

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* Subsequently there were three more fatalities among these cases, bringing the total number of deaths up to 40 in the Bolton-upon-Dearne Urban District.

similar except that the Chevet Sandstone outcrops at the surface, and is followed by outcrops of the Shafton seam of coal, as at the Dearne Valley Colliery in the parish of Little Houghton. This outcrop occurs owing to the dip of the strata from south-west to north-east. In addition to this dip, there are several faults with dislocation of the strata—one of these runs east and west to the north of Bolton-upon-Dearne and another runs north-west and south-east to the west of the village. The latter throws the strata down to the north about 150 feet.

The Sanitary Circumstances and Administration of the Districts concerned.—A brief description of the Sanitary circumstances and administration of the districts invaded by Enteric Fever during this epidemic is given in Appendix II.

In the Bolton-upon-Dearne Urban District the birth rate was 37·4 and the general death rate 14·0 per 10,000; and in the Darfield Urban District the corresponding rates were 30·5 and 11·4, for the year 1920.

The outstanding loans in the Bolton-upon-Dearne Urban District for general purposes amounted to 21,660*l.* and for Housing 243,404*l.* In the Darfield Urban District the corresponding amounts were 10,424*l.* and 15,692*l.*

The following table (Table I.) shows the area, number of inhabited houses, population, the rateable and assessable value of the two Urban Districts and the three parishes of the Rural Districts to which the epidemic of Enteric Fever was practically limited:—

TABLE I.

Showing the acreage, number of inhabited houses, population at the Census of 1921, *and the rateable and assessable value of the districts concerned.*

District.	Acreage.	Census of 1921.		Rateable Value.	Assessable Value.
		Inhabited Houses.	Population.		
Bolton-upon-Dearne U.D.	2,325	2,323	11,947	42,860	42,180
Darfield U.D. - - -	2,018	1,144	5,566	19,105	18,376
Great Houghton Parish -	1,648	443	2,292	13,520	13,040
Little Houghton Parish -	669	93	522	7,999	7,779
Billingley Parish - -	863	41	170	5,395	5,207
Totals - -	7,523	4,044	20,497	88,879	86,582

Past History of Enteric Fever in the Invaded Area.—The prevalence of Enteric Fever in the several districts during the ten years preceding the outbreak of 1921 is shown in the following table :—

TABLE II.

Showing for the districts concerned in the outbreak of Enteric Fever in the year 1921 *the number of notified cases of this disease during the ten years* 1911–20 *inclusive.*

Year.	No. of notified cases of Enteric Fever.					
	Bolton-upon-Dearne U.D.	Darfield U.D.	Great Houghton Parish.	Little Houghton Parish.	Billingley Parish.	The Combined Area.
1911	4	1	—	—	—	5
1912	1	—	—	—	—	1
1913	—	2	—	—	—	2
1914	4	4	1	—	—	9
1915	14	—	1	—	—	15
1916	1	1	—	—	—	2
1917	1	—	—	—	—	1
1918	—	—	—	—	—	—
1919	—	1	—	—	—	1
1920	—	2	—	—	—	2
Totals -	25	11	2	—	—	38

This table shows that there had been little prevalence of Enteric Fever in these districts during the ten years preceding the outbreak of 1921.

HISTORY OF THE ENTERIC FEVER EPIDEMIC OF 1921.

For convenience of consideration the epidemic is divisible into two distinct outbreaks as regards distribution and probable origin, although in point of time there was some overlapping between the two.

The first outbreak extended to all the districts mentioned above, while the second was limited to the village of Bolton-upon-Dearne. The number of cases of Enteric Fever, their

probable date of onset, and the districts in which they occurred, are set out week by week in the following table (Table III.):—

Table III.

Showing the number of Enteric Fever cases, their probable date of onset, and the districts in which they occurred week by week from 17th July to 24th December 1921.

Week ended.	First Outbreak.						Second Outbreak	Total of both Outbreaks.
	Bolton-upon-Dearne U.D.	Darfield U.D.	Great Houghton Parish.	Little Houghton Parish.	Billingley Parish.	Total of First Outbreak.	The Village of Bolton-upon-Dearne	
1921.								
July 23	5	2	—	—	—	7	—	7
„ 30	13	4	—	1	1	19	—	19
Aug. 6	10	2	1	—	—	13	—	13
„ 13	4	4	4	—	—	12	—	12
„ 20	3	1	5	—	—	9	—	9
„ 27	2	1	—	—	—	3	—	3
Sept. 3	4	—	—	—	—	4	—	4
„ 10	3	2	—	—	—	5	—	5
„ 17	5	3	1	—	—	9	—	9
„ 24	—	1	—	—	—	1	—	1
Oct. 1	3	4	—	—	—	7	—	7
„ 8	2	—	—	—	—	2	2	4
„ 15	1	1	—	—	—	2	17	19
„ 22	5	1	—	—	—	6	57	63
„ 29	7	1	—	—	—	8	58	66
Nov. 5	7	4	—	—	—	11	53	64
„ 12	3	—	—	—	—	3	33	36
„ 19	1	2	—	—	—	3	16	19
„ 26	2	—	—	—	—	2	14	16
Dec. 3	—	—	—	—	—	—	2	2
„ 10	7	—	—	—	—	7	6	13
„ 17	3	—	—	—	—	3	1	4
„ 24	1	—	—	—	—	1	1	2
Totals	91	33	11	1	1	137	260	397

It appears from this table that the first recognised cases occurred simultaneously in the Bolton-upon-Dearne and Darfield Urban Districts, and these were followed by one case in each of the parishes of Little Houghton and Billingley, and then by cases in the parish of Great Houghton. The onset of the illness of the greatest number of cases in any week, viz., 19, took place in the week ending 30th July. After a month the number of attacks diminished, and the subsequent cases were mainly secondary cases; the disease lingered on in the village of Highgate until December.

In October a second outbreak occurred in the village of Bolton-upon-Dearne, the onset of the first case taking place in the week ending 8th October. This village had been singularly free from cases during the first period of Enteric Fever prevalence. Investigation showed that the second and localised outbreak was attributable to local conditions, and was a direct sequence of the first and wider-spread outbreak.

The following table (Table IV.) indicates the proportions in which, during the epidemic, the inhabitants of Bolton-upon-Dearne and Darfield Urban Districts and the parishes of the Rural Districts, respectively, were attacked by and died of Enteric Fever. The data referable to the second outbreak, limited to the village of Bolton-upon-Dearne, are shown separately and are not included in those given for Bolton-upon-Dearne Urban District.

TABLE IV.

Showing for the Bolton-upon-Dearne and Darfield Urban Districts and the parishes of Great and Little Houghton and Billingley the population at the Census of 1921, *the number of attacks by, and deaths from, Enteric Fever from* 17*th July to the* 24*th December* 1921, *together with the attack rates and death rates from Enteric Fever per* 1,000 *inhabitants in each instance. The number of cases in the village of Bolton-upon-Dearne that occurred between* 2*nd October and* 24*th December are not included with those of the whole Urban District and are shown separately.*

District.	Population 1921.	No. of attacks by Enteric Fever.	Attack rate per 1,000 of Population.	No. of Deaths from Enteric Fever.	Death rate per 1,000 of Population.
Bolton-upon-Dearne U.D. (first outbreak only).	11,947	91	*7·6*	11	*0·92*
Bolton-upon-Dearne Village (second outbreak only).	3,581* (estimated).	260	*72·6*	29	*8·1*
Darfield U.D. - -	5,566	33	*5·9*	5	*0·90*
Great Houghton Parish -	2,292	11	*4·8*	—	—
Little Houghton Parish -	522	1	*1·9*	—	—
Billingley Parish -	170	1	*5·9*	—	—
Totals - -	20,497	397	*19·4*	45	*2·2*

* Included in population of Bolton-upon-Dearne U.D.

The Little Houghton and Billingley rates are calculated on populations which are numerically small; they cannot therefore properly be regarded as affording a secure basis for comparison.

From this table it will be seen that in the first outbreak the greatest number of cases and the highest attack rate occurred

in the Bolton-upon-Dearne Urban District. In this Urban District there are three centres of population—the villages of Bolton-upon-Dearne, Goldthorpe and Highgate. The number of cases of Enteric Fever that occurred in these three villages during the first and second outbreaks was 281, 34 and 36 respectively.

Further, it will be seen that in the second outbreak, in which the cases were limited almost entirely to the village of Bolton-upon-Dearne, slightly more than seven in every hundred of the population suffered attack. Such an incidence of attack falling in a village community constituted a local calamity.

The succeeding table (Table V.) shows for the whole of the invaded districts in the first outbreak, and for the village of Bolton-upon-Dearne only in the second outbreak, the incidence of the disease in relation to age and sex as regards both attacks and deaths.

Table V. (*see* page 11).

In the next table (Table VI.) is set out the case fatality of the Enteric Fever in various age groups.

Table VI.

Showing for the several districts between 17th July and 24th December 1921 the number of persons attacked by and the deaths from Enteric Fever at certain age groups, and the case fatality.

Age Groups.	Number of Persons Attacked.	Number of Deaths.	Number of Deaths per cent. of Attack.
0–10	113	6	*5·3*
11–20	145	16	*11·0*
21–30	55	5	*9·1*
31–40	42	3	*7·2*
41–50	25	10	*40·0*
51 upwards	17	5	*29·4*
Totals	397	45	*11·3*

This table shows that with increasing age the liability to a fatal issue to the illness becomes greater. The number of patients attacked up to 40 years of age was 355, and there were 30 deaths, a case fatality of 8·4 per cent.; over 40 years of age there were 42 attacks and 15 deaths, a case fatality of 35·7 per cent.

The following table (Table VII.) shows the number of houses in the several districts invaded by Enteric Fever; and the number of houses in which more than one case occurred, with the house invasion rate. The data relating to the second outbreak are not given in the table; they are shown separately in Table VIIa.

TABLE V.

Age Group.	First Outbreak.						Second Outbreak.						Total of both Outbreaks.					
	Attacks.			Deaths.			Attacks.			Deaths.			Attacks.			Deaths.		
	Male.	Female.	Both sexes.	Male.	Female.	Both sexes.	Male.	Female.	Both sexes.	Male.	Female.	Both sexes.	Male.	Female.	Both sexes.	Male.	Female.	Both sexes.
0–10	17	15	32	—	—	—	39	42	81	5	1	6	56	57	113	5	1	6
11–20	31	13	44	3	2	5	45	56	101	7	4	11	76	69	145	10	6	16
21–30	12	8	20	3	1	4	13	22	35	1	—	1	25	30	55	4	1	5
31–40	9	10	19	1	—	1	13	10	23	—	2	2	22	20	42	1	2	3
41–50	10	4	14	1	2	3	4	7	11	5	2	7	14	11	25	6	4	10
51 upwards	5	3	8	3	—	3	5	4	9	2	—	2	10	7	17	5	—	5
Totals -	84	53	137	11	5	16	119	141	260	20	9	29	203	194	397	31	14	45

This table shows that the largest number of attacks and deaths occurred in the age groups 11–20; and whereas in the first outbreak there were more males attacked than females, the reverse was the case in the second outbreak. Taking the two outbreaks together, the number of attacks in both sexes closely coincides. In each outbreak the deaths among males were more than double the number of deaths among females.

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Table VII.

Showing for the several districts the number of houses invaded by Enteric Fever from 1st July to 24th December 1921; the number of houses in which more than one case of the fever occurred; together with the rate of invasion on the houses as a whole and the percentage in each instance of the invaded houses having one and having more than one case of the fever, respectively.

No. of houses in the several districts.	Total number of houses invaded.	Per-centage of houses invaded.	No. of houses with						Percentage of invaded houses having—	
			But a single case.	2 cases.	3 cases.	4 cases.	5 cases.	6 cases.	One case.	More than one case.
4,044	94	*2·3*	71	14	3	3	1	2	*75·5*	*24·5*

Table VIIa.

Showing similar data for the second outbreak in the village of Bolton-upon-Dearne only.

744	148	*20·0*	85	33	18	7	3	2	*57·4*	*42·6*

It will be seen that in the first outbreak as many as 2·3 per cent. of the houses in the area covered by the epidemic were affected, and that 24·5 per cent. of the invaded houses had multiple cases. In the second outbreak, limited to the village of Bolton-upon-Dearne, no less than 20·0 per cent. of the houses in the village proper were invaded by Enteric Fever, while in 42·6 per cent. of the invaded houses more than one case occurred.

Type of the Disease.—The clinical features of the disease included a large variety of degrees of Enteric Fever from a very mild form to an intense toxæmia causing death in the second week of the illness; the proportion of severe cases was highest among the earliest group notified. A number exhibited a well defined roseola, epistaxis marked the onset in several cases and was followed by headache, deafness and anorexia. Several complained of abdominal pains at the onset of their illness, and one was operated upon for suspected appendicitis with fatal result. Diarrhœa was not a frequent symptom; many patients suffered from constipation. Not a few of the severe cases had more than one hæmorrhage; and one patient, who had been treated for "influenza," died of perforation of the bowel some 48 hours after eating bread and butter. Many

patients had more or less severe laryngitis and bronchitis, in some instances developing into broncho-pneumonia. Some, indeed, were originally notified as suffering from pneumonia, and in one or two instances died before the occurrence of secondary cases in the same house led to revision of the diagnosis. Nervous symptoms were prominent, certain patients were wildly delirious, others were comatose for days. Some patients had not sought medical advice.

In almost every case a specimen of the blood was tested for Widal's reaction to B. typhosus with positive result.

From the point of view of public health administration one of the difficulties experienced in dealing with the outbreak was the prevalence of mild cases exhibiting no marked constitutional disturbance. Such cases occurred specially among children, and notwithstanding the great care taken in the investigation of doubtful cases of illness, it is conceivable that a certain number of these cases escaped detection.

Introduction of the Disease into other Sanitary Districts.—To what extent the infection of Enteric Fever was carried into other areas is not known, but it was ascertained that three persons who had visited Bolton-upon-Dearne village during the period of the second outbreak developed the disease in Leeds, Sheffield and Halifax respectively.

Sanitary Condition of the invaded Area.—The Sanitary administration of the invaded area is carried on by the Urban District Councils of Bolton-upon-Dearne and Darfield, and by the Rural District Councils of Hemsworth and Barnsley. It was on the Sanitary Committee of the Bolton-upon-Dearne Urban District Council, to which are allocated the various duties devolving on a Sanitary Authority, that the onus of dealing with the epidemic principally fell.

The villages concerned in the epidemic are all colliery villages. Although they are all sewered and have sewage disposal works, there are still a large number of midden privies which receive excrement and refuse. These are scavenged by the District Councils who all employ their own staff of workmen acting under the supervision of the Sanitary Inspector. The oldest and most insanitary property is in the village of Bolton-upon-Dearne; the other two villages in the Bolton-upon-Dearne Urban District, Goldthorpe and Highgate, are more modern, and the houses are in better condition. There are parts of the villages of Darfield, Great and Little Houghton and Billingley where the conditions are closely allied to those obtaining at the village of Bolton-upon-Dearne.

The nuisances that exist are mainly those associated with the midden privy method of excrement and refuse disposal, the dampness of old houses, and in places the crowding of houses on area, and the overcrowding of persons in houses. The main roads are generally good whereas the back lanes are undrained,

not metalled, muddy in winter and dusty in summer and in need of more effective cleansing.

Water Supply.—Originally the water supply of the invaded area was obtained by pumps from shallow wells sunk into the sandstone of the Chevet Rock; such wells still exist and are in use in Bolton-upon-Dearne village; but there are none at Highgate or Goldthorpe, nor are there any in use in Darfield village. There are a few wells in certain parts of the villages of Great and Little Houghton and Billingley. With the growth of the population in these mining villages a water scheme developed. About the year 1875 the Dearne Valley Waterworks Company began to supply the district with a piped supply of water from a deep well at Everill Gate, Broom Hill, Wombwell. Subsequently other sources of water were brought into the scheme, and the Waterworks Company was superseded by the Dearne Valley Water Board, constituted by Act of Parliament on 4th April 1920. This Board took over all the plant and undertakings of the original Company. It supplies Bolton-upon-Dearne, Darfield, Wombwell and Hoyland Urban Districts, Great and Little Houghton parishes in the Hemsworth Rural District, and Billingley Parish in the Barnsley Rural District.

Within this area Bolton-upon-Dearne and Darfield Urban Districts and the parishes of Billingley and Great and Little Houghton form a separate unit supplied by water pumped from Dearne Valley Colliery. Mr. Good, the Manager of the Dearne Valley Water Board, stated that during 1921 Dearne Valley Colliery water had been supplied to this unit and nowhere else, and that no water from any other source had been turned into the mains supplying this area.

CIRCUMSTANCES AND CAUSATION OF THE FIRST OUTBREAK.

In searching for the factors concerned in the causation of the first outbreak, the general sanitary circumstances, the sewerage and drainage, the milk and food supply and the water supplies were investigated. No agency could be regarded as affording a satisfactory explanation unless it could be shown to be common to the two urban districts and the three rural parishes, and of a sort capable of disseminating the illness in a manner consistent with the facts observed. Therefore the unwholesome condition of individual dwellings and their surroundings and the particular methods of excrement disposal, could be dismissed from consideration as not conceivably serving to account for the sudden and widespread prevalence of the disease. Regarding the subsequent persistence of the disease in the districts after its first introduction, however, these matters became of great import.

The several districts have distinct sewerage schemes and in consequence the probability of the sewerage systems having any bearing on the outbreak could be dismissed.

There remained for consideration the agencies commonly associated with Enteric Fever prevalence,—milk, foods and water.

The Milk Supply.—Inquiry into the circumstances of the early cases of Enteric Fever showed that in the Bolton-upon-Dearne Urban District one patient had not consumed milk for some weeks prior to his illness, 14 used condensed milk only and the remaining eight obtained their milk from six different vendors. These milk vendors did not have a common source of supply and in two instances the milk came by train from outside the district. There was no common milk supply for the four persons attacked in the Darfield Urban District; they purchased their milk from four different vendors, who in turn did not receive milk from a common source. The first persons attacked in the parishes of Great and Little Houghton and Billingley obtained milk from six different sources independent of each other. The available evidence definitely excluded milk as the means by which the infection had been carried. Examination of the age and sex incidence failed to show any special incidence of the disease on women and children characteristic of epidemics of Enteric Fever when the infection is milk borne.

Other Foods.—No information could be obtained as to the common consumption of celery, watercress or other green vegetables eaten raw, *i.e.*, lettuce, which would explain the wide distribution of the malady. The possibility of ice-cream as a vehicle by which infection might have been carried was investigated, but no ice-cream had been consumed by persons attacked by the fever at a date consistent with it having conveyed the infection of the disease. Shellfish, such as mussels, are out of season at the time of year when this outbreak commenced and further, no history could be obtained of the eating of cockles or other shellfish by the patients within the period during which they must have acquired infection. There had been no common resort to a fish shop for "fish and chips" or similar cooked food.

Water-supply.—The distribution of the cases was circumscribed and limited to Bolton-upon-Dearne Urban District, Darfield Urban District, and the parishes of Great and Little Houghton and Billingley. The area of these districts and parishes is coincident and coterminous with the area supplied with water by the Dearne Valley Water Board from a supply obtained from the Dearne Valley Colliery. At Darfield, Great and Little Houghton and Billingley, the public piped supply was the source whence the persons attacked obtained their drinking water. At Bolton-upon-Dearne village, where the water-supply from the Colliery had been insufficient in quantity

the cases occurred in households where the piped supply was in some measure adequate to their needs and which had not habitually resorted to the public pumps for drinking water. At Highgate and Goldthorpe the only available water supply is the water of the Dearne Valley Water Board. Inquiry showed that throughout the invaded districts the only factor common to the persons attacked by Enteric Fever was the consumption of water pumped from the Dearne Valley Colliery, and that these persons had habitually consumed this water. It appeared probable, therefore, that specific pollution of the water had taken place at its source and not in the course of its distribution.

On 23rd August a specimen was taken at the Colliery of the water as it was pumped from the pit and before it received any treatment. This sample was examined bacteriologically at the West Riding County Laboratory, Wakefield, with the result that it was found to be polluted. The report, which is given in full in Appendix Ia, Sample 1, states : " this examina-
" tion shows a certain amount of pollution, and the presence of
" streptococci would make one suspicious of human excrement." This finding tended to confirm the suspicion that the Dearne Valley Colliery water was the means by which the infection of Enteric Fever was being distributed.

The Dearne Valley Colliery Water-supply. — Dearne Valley Colliery was originally an outcrop working or " day-hole." At this point the Shafton Seam of coal dips at an inclination of one foot in 16 under the Chevet bed of sandstone and the Dearne Valley Colliery working of this seam extends for nearly $1\frac{1}{2}$ miles from the outcrop. The Colliery underlies portions of the parish of Little Houghton in which is the " pit-head," the parish of Great Houghton in which the village of the same name is situated over the northern limit of the Colliery, and the parish of Billingley. The village of Billingley is situated immediately beyond the southern limit of the Colliery. The working of the Shafton Seam has been abandoned for some time owing partly to the wetness of the working, and it is water from the abandoned and higher levels that is pumped to supply the area named above.

The Colliery is still worked, but the coal is obtained from the Barnsley Seam, which is situated at a lower level than the Shafton Seam and there is no connexion between the two.

The water from the old workings in the Shafton Seam, known locally as the " clean side," is collected in an artificial pound, built of brick and concrete, from which it is pumped direct to the treatment plant at the surface. Examination of the conditions under ground in the Colliery revealed no obvious opportunity for possible pollution of the water in the " clean side," to which only six men in all have access for the purpose of working the pumps. There was no history of recent illness of a suspicious nature among these men. Samples of blood were taken from all six and submitted to bacteriological investigation,

with negative result to the Widal reaction for B. typhosus in each instance.

The water collected on the "clean side" of the pit is pumped to the surface and there runs into a treatment plant, which is situated in a brick building with a slate roof. Here the water is mixed with measured quantities of an emulsion of slaked caustic lime, and then passes into two sedimentation tanks. The lime is added to this water owing to the presence of sodium carbonate in amounts of six parts per 100,000 in the water as pumped from the mine. The sodium carbonate is removed as calcium carbonate after the lime treatment, and most of this settles in the sedimentation tanks before the water leaves them. On leaving the sedimentation tanks the water flows through coarse filters and then through sand filters. These filters are in series. The sand filters have only a small superficial area, viz., 130 square feet, and the volume of water passing through them is 10,000 gallons per hour. It is obvious that such filtration can have but little effect upon the bacterial content of the water. From the filters the water passes to a tank of 4,000 gallons capacity and thence to the service pumps which deliver water under a pressure of about 80 lbs. weight per square inch into a six-inch main service pipe at a rate of 10,000 gallons per hour, or 240,000 gallons per day of 24 hours. Pumping is continuous, and the average quantity of water pumped for the month of August was 237,000 gallons a day; this represents a supply of 11–12 gallons per head of the total population of the district supplied. The amount of water pumped, however, is stated to be limited to the capacity of the mains to receive it; the actual amount that can be raised by the pumps is said to be about three times this amount.

The service main from Dearne Valley Colliery joins the original pumping main from Broom Hill in Fitzwilliam Road, Darfield. Where this road joins the main road, one branch main runs *viâ* Middlecliffe to Sandhill, Great Houghton; and another service main is carried *viâ* King Stocks through Billingley on to Highgate, Goldthorpe and Bolton-upon-Dearne. The main linking up Great Houghton is also connected with a main through Billingley village, and this main joins the King Stocks route in the centre of the village.

The service main to Great Houghton supplies a tank near Houghton Old Hall, at 225 feet O.D. This tank is 20 feet by 20 feet by 6 feet, and has a capacity estimated at 14,000 gallons. The service main to Highgate and Goldthorpe supplies a service tank at Goldthorpe on the eastern boundary of the district adjoining Hickleton. This tank is at 200 feet O.D., it is circular, 18 feet in diameter, and 18 feet deep, with an estimated capacity of 28,000 gallons.

The main service water pipe is reduced at Highgate from a six-inch pipe to a four-inch pipe which runs to the tank at Goldthorpe. From the Goldthorpe tank a four-inch main runs

down Furlong Road conveying water to Bolton-upon-Dearne. At the Bolton-upon-Dearne end of Furlong Road this four-inch main is connected with three other four-inch mains, one running to High Street, Bolton, and Wath Road, one to Lowfield Road, and a third down Mexborough Road.

The capacity of the main from Highgate to Goldthorpe and thence to Bolton-upon-Dearne proved inadequate as an aqueduct for the needs of some 8,000 persons. Complaints as to water shortage in Goldthorpe and Bolton-upon-Dearne have been general since the year 1906. At times there has not been sufficient water in the villages to flush the water-closets, and frequently it is an impossibility to get water for a bath except after midnight. Locally it has been suggested that building operations at Goldthorpe and Bolton-upon-Dearne in connection with the Bolton-upon-Dearne Housing Scheme have contributed to the shortage of water during the day time in Bolton-upon-Dearne village. The water-supply for these new houses, and the works thereon, taps the four-inch main in Furlong Road, between Goldthorpe and Bolton, and thus reduces the pressure of water. It will be realised that Bolton-upon-Dearne village is the last village on the line of the water mains. The water-supply in this village has recently been improved, a new four-inch main having been laid to it from Highgate down Highgate Lane. This was done in November 1921, as one of the means to combat the outbreak in Bolton-upon-Dearne village.

But, in general, it may be said that the service of the public water-supply is inadequate for the district. This is due almost entirely to the needs of the population out-growing the carrying capacity of the mains and not to any actual shortage of water at the source.

The manner in which the Water may have become specifically contaminated.—No definite cause for the pollution of the water was discovered. The water is derived from the "clean side" of the colliery which is not being worked for coal, and an inspection of the conditions underground showed that it consists entirely of water which percolates through the overlying strata. There is no "spring" or large influx of water at any particular point of the pit. Survey of the gathering ground above the old workings of the colliery showed that the area was mainly arable ground in cultivation. The villages of Little and Great Houghton, to the sanitary condition of which reference is made in Appendix II., are both situated over the colliery and to the west of the latter is a wood known as Little Park. During the coal strike, between April and July 1921, many people raided this wood for fuel, and a considerable amount of excreta was observed among the undergrowth and in ditches. In the wood and near by, the sandstone of the Chevet Rock, which here overlies the coal measures, is near the surface and shows many cracks and fissures. During the hot dry weather of June 1921, the surface of the ground overlying the colliery

was baked and cracked and it is conceivable that a shower of rain might carry down polluting material from the surface to lower levels. The possibility that the water may at any time be contaminated by excreta or other infective material on the gathering ground overlying the colliery cannot be disregarded.

ACTION TAKEN TO LIMIT THE SPREAD OF THE DISEASE.

The Water-supply.—On the appearance of these cases of Enteric Fever at Bolton-upon-Dearne Urban District and the neighbouring districts at the beginning of August 1921, the Urban District Council of Bolton-upon-Dearne published notices advising all persons to boil the water for at least 20 minutes before using it for drinking purposes. Similar notices were subsequently issued by the other Councils of the districts invaded.

After consideration of a preliminary report by me, the Ministry of Health, on 13th September, 1921, requested the Dearne Valley Water Board to chlorinate the supply from Dearne Valley Colliery, in order to render it safe for human consumption, and to obtain expert advice as to how this should be done.

On 12th September this water plant and colliery were visited by Mr. John Evans of Sheffield, the expert engaged by the Dearne Valley Water Board, and Major Turner, the Engineer of Rotherham County Borough Waterworks.

On 14th September when I again visited the Dearne Valley Colliery to ascertain what steps had been taken, the Manager of the Colliery told me that the water was chlorinated for the first time on 9th September, 1921, and that two *ounces* of bleaching powder were being added each hour to the water as it was delivered from the treatment plant described above to the storage tank of 4,000 gallons capacity, on its way to the service pumps.

I pointed out that two ounces of bleaching powder in 10,000 gallons of water added casually each hour, without mixing, was so small a quantity that the available chlorine would hardly suffice to sterilise the water. Moreover, by this method some of the water would be excessively charged with bleaching powder, while the rest had none.

I suggested that one pound weight of bleaching powder mixed in the apparatus formerly used for adding slaked lime should be added to the water at such a rate that it would be equally mixed with the 10,000 gallons of water passing through the plant each hour. This would allow the chlorine to re-act with the water in the sedimentation tanks of the plant before filtration, and also in the 4,000 gallons storage tank after filtration, before being pumped into the service main. The quantity of available chlorine in this amount of bleaching powder is sufficient to give $2\frac{1}{2}$ to 3 parts of chlorine in a million parts of water.

This treatment was recommended as an emergency measure, and was carried out for one week. At the same time the Manager of the Water Board, Mr. Good, was reminded that his Board must be advised by their expert as to the results obtained by this treatment of the water, and of any modifications that were necessary.*

The quantity of bleaching powder added to the water at Dearne Valley Colliery was reduced on 21st September to half-a-pound per hour—from 4th October to 22nd October, the amount of bleaching powder added was reduced still further to a quarter-of-a-pound per hour. On 22nd October the quantity was again cut down, this time to two ounces an hour or three pounds weight per day of 24 hours.

One of the reasons given to me for this continual reduction in the amount of bleaching powder added for the chlorination of the water at Dearne Valley Colliery was that there were complaints from many consumers that the water was rendered so unpalatable by chlorination that no one could drink it. My own inquiries made locally did not elicit information in support of this complaint.

At the outset when the bleaching powder was added to the flowing stream of water without mixing, there is a possibility that some parts of the supply were overcharged. But Mr. Watkin, the manager at Dearne Valley Colliery, stated that the quantity of bleaching powder added to the water by the mixing apparatus never exceeded one pound per hour, and that the rate of pumping had been regular and continuous. The average rate for September and October was 237,000 gallons per day of 24 hours.

Subsequent examination of samples of water taken, before any treatment, from Dearne Valley Colliery in October and November, 1921, showed, according to Dr. Sutherland's report (*see* Appendix Ia, Samples 5–7), that the water had much improved in quality, and could at that time be regarded as a safe source of potable water. There is, however, always a risk that this water may be contaminated by excreta, or other infective material, deposited on the gathering ground overlying the Colliery.

Isolation Hospital Accommodation for Infectious Disease.—Bolton-upon-Dearne Urban District Council is one of the constituent authorities of the Wath, Swinton and District Joint Hospital Board that maintains the Wath Wood Isolation Hospital at Wath-on-Dearne. Darfield Urban District Council send infectious cases from their district by agreement to the Barnsley Isolation Hospital which is the property of the Barnsley Town Council. Patients from the Barnsley Rural District are also received into this hospital. The Hemsworth Rural District Council has an Isolation Hospital at Brierley Hill. No difficulty

* In this connexion, *see* Ministry of Health Circular 241. "To Local Authorities—Water-supplies—Chlorination." 15th September, 1921.

was experienced in finding isolation hospital accommodation for the cases of Enteric Fever that occurred in Darfield Urban District and the rural parishes; the reverse was the case as regards the Bolton-upon-Dearne Urban District.

The Wath, Swinton and District Joint Hospital Board, provides isolation hospital accommodation for the Wath Urban District (population 12,866), Swinton Urban District (population 13,925), Bolton-upon-Dearne Urban District (population 11,947), and Greasbrough Urban District (population 3,182), having a total population of 43,920. The Hospital buildings comprise an administration block, a laundry block and five ward blocks having accommodation for 54 patients. The diseases ordinarily treated in the hospital are Enteric Fever, Scarlet Fever and Diphtheria. In non-epidemic times the isolation hospital provision is sufficient for the needs of the districts served.

The ordinary accommodation for Enteric Fever cases amounts to 12 beds in 2 wards, and from the commencement of the epidemic, these wards were overcrowded and the hospital accommodation overtaxed. On 24th August, I found 18 Enteric Fever cases in these wards and two of the nurses subsequently suffered attack by the disease. The demand for isolation of patients in hospital far exceeded the available accommodation with the result that patients could not be promptly removed to hospital and some of them remained in their homes for three weeks after they had been recognised to be suffering from Enteric Fever. Accordingly I visited the Isolation Hospital at Conisborough, belonging to the Doncaster and Mexborough Joint Hospital Board, where I found that beds for Enteric Fever cases were available, and the Bolton-upon-Dearne Urban District Council at once arranged with the Joint Hospital Board to receive cases from their district. Similar arrangements were made with the Hemsworth Rural District Council to admit Enteric Fever cases from Bolton-upon-Dearne Urban District to their Isolation Hospital at Brierley Hill. There were times when delay occurred in the removal of the patients to hospital, owing to the ambulance service being restricted to one motor ambulance from the Wath Wood Hospital, assisted on occasions by the motor ambulance of the Conisborough Hospital.

CIRCUMSTANCES AND CAUSATION OF THE SECOND OUTBREAK.

During October there occurred a sudden and explosive outbreak of Enteric Fever in the village of Bolton-upon-Dearne which had hitherto, in large measure, escaped; there having been only 21 cases in the village during the first outbreak. This second outbreak apparently commenced with two cases having their onset in the week ended 8th October, followed by 17 in the next

week and by over 50 in each of the next three succeeding weeks. It is true that at this time cases were still occurring in other parts of the Urban District of Bolton-upon-Dearne and in Darfield Urban District, but these were secondary cases which owed their infection to direct contact with persons who had been infected during the first outbreak by water derived from the Dearne Valley Colliery. The second outbreak was confined to persons living in the village or to those who had some close connexion with families living there. As a result of inquiries, it was found possible to separate the new cases in Bolton-upon-Dearne village from the secondary cases just alluded to, and the former are shown in a separate column in Table III, while the special incidence on the population and on the houses in Bolton-upon-Dearne village is set forth in Table IV and Table VIIA respectively. The large number of these cases, the explosive character of the onset of the outbreak and the comparative freedom of the village prior to 8th October suggested a fresh source of infection.

Inquiry into the probable cause of this second outbreak resulted in the elimination of milk, shellfish, watercress, ice-cream, &c. Suspicion again fell on the water-supply.

The Public and Local Water Supplies of the Village of Bolton-upon-Dearne.—The public water-supply in the mains had been chlorinated for a month, and the report from the Dearne Valley Water Board's expert, Mr. John Evans of Sheffield, on the bacteriological examination of a sample taken on 3rd October, was favourable (*see* Appendix IA, Sample 5). It was known that the village was at the extreme limit of the mains of the water service. The distribution of the invaded houses showed they were in a part of the village which had not been affected by Enteric Fever in the previous August–September outbreak, and to which the water-supply from the public mains had been inadequate, indeed it had often failed and it was cut off entirely on 27th September and 3rd October. Under these circumstances the inhabitants had grown accustomed not to rely on the service of water from the public mains, and had resorted for their supply to a public pump which is situated in the village at the corner of the High Street at its junction with Thurnscoe Road and Wath Road. This pump draws water from a shallow well immediately below it in the sandstone rock.

Further, certain people after reading the posters put up in August which warned the public to boil the water were prejudiced against the piped-supply and when it was known this supply had been chlorinated they alleged that it was quite undrinkable. The result was that not only residents in the immediate neighbourhood of this pump, but persons not living in the vicinity obtained their drinking water from it; also various other persons who visited the village for one or another purpose drank water from this pump.

Personal inquiry at many of the invaded houses and from patients in hospital elicited the fact that water from the pump in High Street had been habitually used by them for drinking purposes or had been resorted to when the piped-supply failed. Consumption of water from this well was the only factor found to be common among those attacked by Enteric Fever.

The available information pointed to specific infection of the water obtained from this pump, and special inquiry was directed to the matter. The weather had been hot and dry, and the demand on this pump-water had been heavy. The extra demand upon the pump-well-water would cause it to draw upon a wider area than usual, and would probably tend to bring in water from different levels. There had been an exceptionally dry spring and summer, with a remarkably small rainfall. Heavy rain, however, fell at Bolton-upon-Dearne village on 2nd and 3rd October.

The sequence of events indicated that the infection of this well, and probably of other wells in this neighbourhood, took place some time about the middle of September, that it was greatest at the beginning of October, and that it remained operative until the beginning of November.

A sample of the water from the public pump was sent to the Public Health Laboratory of the County Council at Wakefield, on 2nd November, and was found to contain organisms of intestinal origin, and samples of water from other local wells were subsequently examined with similar result. (*See* Appendix Ib, Samples 1–5.)

Manner in which the Local Well-water may have become specifically contaminated.—The well supplying the public pump in High Street is on the north side of the road. The surface is here at an elevation of 120 feet O.D., and the well is driven down for 27 feet through the sandstone of the Chevet Rock to the hard strata overlying the coal measures of the Shafton seam of coal. This well is only dry steined for a distance of 9 feet from the surface. It was opened for examination and measurement on 10th November, when torchlights were lowered for some distance, but no signs of percolation through, or discolouration of the sides could be seen in the first 12 or 15 feet.

Immediately to the north and west of this well is a quarry where the sandstone rock has been worked. Here the rock shows extensive fissures, some of the cracks being 12 inches across. There have also been subsidencies at the north-west side of the quarry, and after one, which took place some 10 years ago, a local well at No. 5, Thurnscoe Road, ran dry. Levels were taken of the area surrounding the well of the public pump in High Street. These show that the lowest part of the quarry is some 10 feet *above* the bottom of the well, and also that the floors of the midden privies at the back of the houses on the north side of High Street, as well as those of The Ladycroft near by, are all several feet above the bottom of the well.

This quarry is now used for mortar-making in connexion with building on the Bolton-upon-Dearne Housing Scheme. The superficial sandstone rock is friable, and this is ground up with lime, &c., to make mortar. In addition to inquiries among the quarrymen careful inquiry was made for any case of recent illness among other workers in the quarry. The contractors purchasing the mortar were visited and interrogated as to any case of illness among their carters or labourers. Two cases of Enteric Fever were thus discovered among these men, but the onset of their illnesses was at a date which brings them within the second outbreak, and they were probably infected by drinking water from the public well, and were not the source of the specific pollution.

Besides persons employed and working in the quarry children use it as a playground. In the first outbreak a case of enteric fever occurred in Wath Road in the village to the west of the public pump. The patient, a boy aged 11 years, was nursed at home by his sister. The onset of his illness was on 22nd July, and he had recovered by the beginning of September, and on recovery played in the quarry with others. On 7th September his sister developed Enteric Fever, but was not removed to the isolation hospital until 29th September. One of his playmates from Priory Road, Bolton-upon-Dearne, contracted typhoid fever in the second outbreak and died of the disease. It may have been that the boy after his recovery from his attack of typhoid fever remained for some time a carrier of B. typhosus either in his fæces or urine, and that he infected the soil of the quarry.

Another possible source of infection was the Bolton-upon-Dearne Feast, which was held in the village from the 13th August to 20th August 1921. A field situated at an elevation of 145 feet O.D., *i.e.*, above and adjoining the quarry was let as a fair field, and on it were erected cocoanut shies, roundabouts, swings, &c. This show had travelled on from Great Houghton, which was one of the first places infected with enteric fever. At Bolton-upon-Dearne the showmen lived in six caravans on the fair field, and the owner of the field complained that the south-east corner of the quarry had been fouled with excrement and rubbish. This part of the quarry has only been worked quite superficially for the friable sandstone, and it stands from 10 to 15 feet above the level of the road in High Street, and only some 35 feet to the north-east of the well of the public pump. There was some illness among the showmen, and one child, 18 months old, died. Although its death was certified as due to bronchitis, the age of this child, and the prominence of pulmonary symptoms among some of the patients who suffered from Enteric Fever in this epidemic, make it advisable to record the incident. But apart from the showmen it has to be remembered that at the time of this "Feast" cases of Enteric Fever were occurring in Bolton-upon-Dearne and the surrounding district. Remains of human

excrement were seen in different parts of the quarry, and it is possible that excreta from infected persons may have been deposited there. Such excreta might easily infect water drawn from the sandstone rock immediately below, and it is this rock which contains the well of the public pump in High Street and other local wells in the vicinity.

It is also possible that excreta from persons infected during the first outbreak may have reached the water in the public well *viâ* middens at the back of High Street or in The Ladycroft. On careful inquiry being made the occurrence of a case which had been missed during the earlier part of the epidemic, and had in consequence not been removed to hospital, was discovered in the High Street. With the shortage of coal fuel, due to the coal strike, there was a lack of ashes in these middens, and with the presence of diarrhœa among the inhabitants during August, these middens are said to have been filled with liquid ordure—to the level of the seats—between the times of emptying. Recent experiments have shown that the ground in the yards at the back of High Street and in the quarry absorbs water "like a sponge."

Water from the public and local wells has been in common use for drinking purposes for many years, and during this time they were probably polluted by soakage from the contents of the privy middens, &c. Enteric Fever had been absent from Bolton-upon-Dearne since the year 1917 until its introduction in the summer of 1921, when the well-water became specifically contaminated.

From the account given above of multiple sources of possible specific contamination of the local well-water, it will not be a matter for surprise that the outbreak of Enteric Fever could not be attributed to any one factor.

ACTION TAKEN AT BOLTON-UPON-DEARNE VILLAGE TO LIMIT THE SPREAD OF THE DISEASE IN THE SECOND OUTBREAK.

Water-supply.—Suspicion that the water in the public well at High Street was the possible source of infection of the fresh series of cases of Enteric Fever did not arise until 31st October, and on that day placards of warning were placed on the pump directing everyone to boil this water for 20 minutes before use as drinking water.

On 1st November samples of water were taken from the well of the public pump by the county sanitary inspector, Mr. Holmes. But on chemical analysis by the county analyst, Mr. F. W. Richardson, of Bradford, the report on the quality of the water was favourable. After bacteriological examination, however, Dr. Sutherland, of the West Riding County Laboratory, reported on 7th November that the water contained organisms of intestinal origin; and on the same day a copy of his report was sent to the Medical Officer of Health for Bolton-upon-Dearne Urban District.

Unfortunately no action was taken by him on its receipt. A copy of this report appears in Appendix Ib, Sample 1.

On my return to the district on 9th November I met Dr. J. R. Kaye, County Medical Officer of Health for the West Riding, at Bolton-upon-Dearne Council offices by appointment, when he informed me of the result of the bacteriological examination of the well-water. The pump of this well was still in action, and I at once advised Mr. J. L. Hawksworth, clerk to the Bolton-upon-Dearne Urban District Council, as representing the local sanitary authority, that the handle of the pump should be removed immediately. This was done on 10th November, and on the same day the handle was removed from another public pump in Furlong Road.

Further investigation was immediately carried out as to the quality of the water in the wells supplying private pumps in Bolton-upon-Dearne village. The reports on the examination of these waters will be found in Appendix Ib, Samples 2, 3, 4 and 5. These reports showed that, on bacteriological and chemical examination, the water in these wells in High Street, Thurnscoe Road and Willow Lane was contaminated by sewage.

As a part of the action taken in dealing with this epidemic the Dearne Valley Water Board were urged to give an adequate supply of their chlorinated water to Bolton-upon-Dearne village; and they promptly laid a new four-inch water main, from the six-inch main service pipe at Highgate, down Highgate Lane to the village. This allowed a larger quantity of water to be supplied throughout the village of Bolton-upon-Dearne than was formerly the case. Towards the end of November, the quality of the water was shown by bacteriological examination of a sample (Appendix Ia, No. 7) taken from the rising main in the colliery, and before the water had been submitted to chlorination, to have considerably improved. With the advent of the new piped-supply of water, steps were taken to abolish all supplies of water for human consumption from the shallow wells in the sandstone at Bolton-upon-Dearne. The public wells were closed, and the one at Willow Lane abolished, the piped-supply of water being made available to the houses there. The occupiers of 42, High Street, and 67, High Street, were warned that the water in their wells was unfit for human consumption, and should only be used for watering stock in the foldyards.

The action taken in closing the public well in High Street was followed by the rapid cessation of primary cases of enteric fever in Bolton-upon-Dearne village.

Assistance received from Medical Practitioners.—The medical practitioners working in Bolton-upon-Dearne were seen personally, and asked to notify at once not only cases in which there could be no doubt that the patients were suffering from Enteric Fever, but all doubtful cases, and not to wait for the confirmation of the diagnosis afforded by a Widal reaction of the patient's blood; this could be carried out subsequently.

In this way, the medical practitioners, by directing attention to doubtful cases of the disease, helped to prevent its spread.

Assistance rendered by Health Visitors.—From 21st November onwards, three health visitors of the County Council staff, and the health visitor of the local authority, were engaged in making house-to-house visits throughout Bolton-upon-Dearne village. They made inquiry to ascertain whether cases of suspicious illness existed, and to explain the necessity for medical attendance on sick persons. This canvassing of the district resulted in the discovery of several "missed" cases and of over-crowded houses.

Severity of the Second Outbreak.—The severity of the second outbreak of Enteric Fever in Bolton-upon-Dearne village can be estimated from the following data. A house-to-house census of the population in the infected area gave a count of 744 houses occupied by 3,581 persons, among whom 260 suffered from Enteric Fever. This represents an attack rate of 72·6 per 1,000 of the population; one person in every 13·8 of the community being attacked.

The Isolation and Treatment of Patients.—The housing conditions in High Street, Bolton-upon-Dearne, the oldest part of the district, are very bad. Proper nursing and treatment in their homes of persons attacked by Enteric Fever were neither obtainable nor possible. Moreover, the home conditions were extremely favourable to the spread of the disease. The isolation hospital accommodation then available proved utterly inadequate to deal with the rush of cases.

On 9th November, Wath Wood Hospital was full as regards beds allocated to Enteric Fever patients and Conisborough and Brierley Hill Hospitals were in the same position. As there were no smallpox cases in the locality, on the following day, 10th November, it was arranged that Barnsley Corporation should allow their Smallpox Hospital at Lund Wood to be occupied by Enteric Fever patients from Bolton-upon-Dearne, and in this way 40 additional beds were provided.

The Wath Wood Joint Hospital Board agreed to move their convalescent Scarlet Fever patients to the Hoober Smallpox Hospital; and the Doncaster and Mexborough Joint Hospital Board consented to remove their Scarlet Fever patients to the Conisborough Smallpox Hospital; by these arrangements some 38 more beds were made available for Enteric Fever patients from Bolton-upon-Dearne. Also the Rawmarsh Urban District Council agreed to admit cases of Enteric Fever from Bolton-upon-Dearne into their hospital up to the number of 19.

These arrangements for securing additional accommodation led to protest from the matrons and superintendents of the hospitals

concerned. They said that the number of trained nurses available on their staffs would be inadequate to deal with such numbers of Enteric Fever patients. They also, quite properly, raised the question of the additional laundry work involved. To meet these protests the West Riding County Council sent to these hospitals as many of their Health Visitors as could be spared to nurse the Enteric Fever patients from Bolton-upon-Dearne. These Health Visitors are fully qualified nurses with certificates of three years' training in a General Hospital. Additional laundry maids were also provided for these hospitals.

Even with the additional hospital accommodation thus secured through the courtesy of neighbouring authorities, there were still cases of Enteric Fever lying at home and in need of proper treatment and effective isolation. Consequently, on 11th November, the Bolton-upon-Dearne Urban District Council were advised to apply to the Education Committee of the West Riding County Council for permission to use the Infants' School in Priory Road, Bolton-upon-Dearne, as a hospital for Enteric Fever patients. This was readily given, and the County Council also provided the equipment, and directed the provision of the necessary sanitary accommodation : artificial lighting and heating were already installed. The matron of the School Hospital resided with the headmistress of the Infants' School in Priory Road : two new houses on the Bolton-upon-Dearne Housing Scheme were opened as a nurses' hostel, the furniture being provided by the County Council. Food was provided by the "National Kitchen" at Goldthorpe, a most excellent institution. This school was opened as a Hospital with 30 beds, and the first patients were received there on 14th November. But as fresh cases were discovered day by day, it was soon extended to accommodate 43 patients. Notwithstanding this, there were on 21st November still some 60 known patients for whom there was no accommodation in hospital. Therefore I visited Rotherham and ascertained that a ward in the Rotherham Isolation Hospital was empty, and negotiations were made for the use of this ward for Enteric Fever patients from Bolton-upon-Dearne. On 23rd November the consent of the Rotherham County Borough Sanitary Authority was obtained, and by 21st December, 27 beds in this hospital were occupied by patients from Bolton-upon-Dearne. The Chief Constable of Rotherham lent his Red Cross Motor Ambulance for the removal of patients from Bolton-upon-Dearne to Rotherham. The School Hospital in Bolton-upon-Dearne was reserved, as far as possible, for serious cases of the disease who could not bear the long journey to the isolation hospitals of the neighbouring Sanitary Authorities.

The patients suffering from Enteric Fever at Bolton-upon-Dearne were received into the hospitals of the neighbouring authorities with every care and attention and much personal kindness.

On 23rd November there were still in Bolton-upon-Dearne some patients suffering from Enteric Fever and who remained at home under unfavourable conditions as to treatment and isolation.

At a special meeting of the Bolton-upon-Dearne Urban District Council on 23rd November I drew their attention to houses in their district in which cases of Enteric Fever were being kept at home with little or no attempt at isolation; subsequently several of these patients were removed to hospital.

On 21st December the position was as follows :—

Hospital.	Admitted.	Died.	Discharged.	Remaining.
Wath Wood -	78	9	34	35
Conisborough -	41	4	14	23
Brierley Hill -	16	3	4	9
Rawmarsh -	19	—	1	18
Bolton School -	45	2	—	43
Lund Wood -	40	1	1	38
Rotherham -	30	1	5	24
	269	20	59	190

In addition to the cases shown in the above table, there were at this time 23 others remaining in their own homes. The diagnosis in ten of these was doubtful, while six had recovered and their homes had been cleansed and disinfected. Of the remaining seven, five were in houses provided with water closets, which minimised the risk of infection, while at the other two houses midden privies only were available. At one of the latter dwellings the excreta from the patient were disinfected and buried, and at the other special buckets were used, which were collected and properly disinfected by officers of the District Council. Examination of the urine and fæces before the discharge of a patient was the routine practice adopted at the isolation hospitals. This system was extended to include the cases nursed at home. The usefulness of the measure was illustrated by the fact that a patient continued to pass B. typhosus in his urine for seven weeks after apparent recovery from the disease.

In addition to the 20 deaths in hospital, there had been, by the 21st December, six deaths among patients nursed at home. Subsequently there were three more, making a total of 29 in the second outbreak.

When it is remembered that the hospital opened in the Infants' School at Bolton-upon-Dearne was reserved for severe cases of Enteric Fever, often in the second and third week of their illness at the time of their removal, the results of treatment in this hospital were remarkable; among these patients there were only two deaths.

Action taken by the Local Sanitary Authorities and their Officers.—When I first visited Bolton-upon-Dearne the full significance of the epidemic had not been realised by the inhabitants of the invaded districts. But as soon as the local Sanitary Authorities became aware of the position, they recognised their responsibility, and immediately took every possible step to cope with the situation. In this endeavour they were loyally supported by their officers. The stress fell heavily on Mr. J. Ledger Hawksworth, the Clerk of the Bolton-upon-Dearne Urban District Council, and Mr. G. H. Bates, the Sanitary Inspector.

The circumstances of Bolton-upon-Dearne Urban District are such that it alone cannot support a Medical Officer of Health who can devote the whole of his time to the duties of his office. On the resignation of Dr. Lawl, during the epidemic, the Council appointed as their Medical Officer of Health Dr. Morris, who is a general practitioner in the district. It is only fair to Dr. Morris to state that at the time of his appointment he had in his private practice many severe cases of Enteric Fever that demanded his personal attention, and that he had no previous experience of public health administration. He came into office under circumstances that would have taxed the capacity of a trained and experienced Medical Officer of Health to its fullest extent. I have no hesitation in stating that the assistance he rendered during the epidemic exceeded that which could reasonably be expected from a Medical Officer of Health who receives a sum of 80*l.* per annum as his official salary.*

The assistance given by the West Riding County Council and by their public health staff in the collection of samples of water and examination of the specimens of water, blood and urine was most helpful. I wish to direct special attention to the valuable work of the Health Visitors during the epidemic, both in the district and at the hospitals. This constituted no part of their ordinary duties, and they carried it through in a manner which is beyond praise.

CONSIDERATIONS ARISING FROM STUDY OF THE EPIDEMIC.

Study of this epidemic of Enteric Fever indicates that the first outbreak can be attributed to specific contamination of the public water supply of the area, and that this must have taken place about the middle of July. The specific pollution must have been relatively small in amount and was distributed through a comparatively large volume of water. The period during which the water was capable of disseminating infection was probably a limited one. It would seem that the capacity of the water to produce definite clinical cases of Enteric Fever was at

* In addition he receives 20*l.* as Medical Officer of the Maternity and Child Welfare centre and 23*l.* 9*s.* 6*d.* bonus.

first slight, as the persons primarily affected exhibited only signs of gastro-intestinal disturbance, *i.e.*, diarrhœa and malaise. The potency of the water to infect became progressively greater until definite clinical cases of Enteric Fever were recognised, after which the infective ability of the water diminished and during the period of decline mild cases of the disease again occurred which would not have been recognised as cases of Enteric Fever but for their association with antecedent cases of illness which were definite cases of the disease. These observed phenomena can be explained on the assumption that specific infection gained access to the water supply at first gradually in small and afterwards in greater amount and finally became exhausted. The chlorination of the water may have played no part in the subsidence of the Enteric Fever incidence, and it will be seen from this report that the methods first adopted in the chlorination of the water could not be regarded as in any way efficient so far as sterilisation of the bacterial content of the water was concerned, and effective chlorination of the water was not persisted in. I would point out that the water supply from the Dearne Valley Colliery is derived from a gathering ground on which opportunities for its pollution are multiple and that it cannot be regarded as a " safe " supply. Outbreaks of Enteric Fever, of Cholera or of other waterborne diseases are liable to occur in this district so long as the public water supply is derived from the present source and so long as the water is not rendered innocuous by appropriate treatment before it is delivered to the consumer.

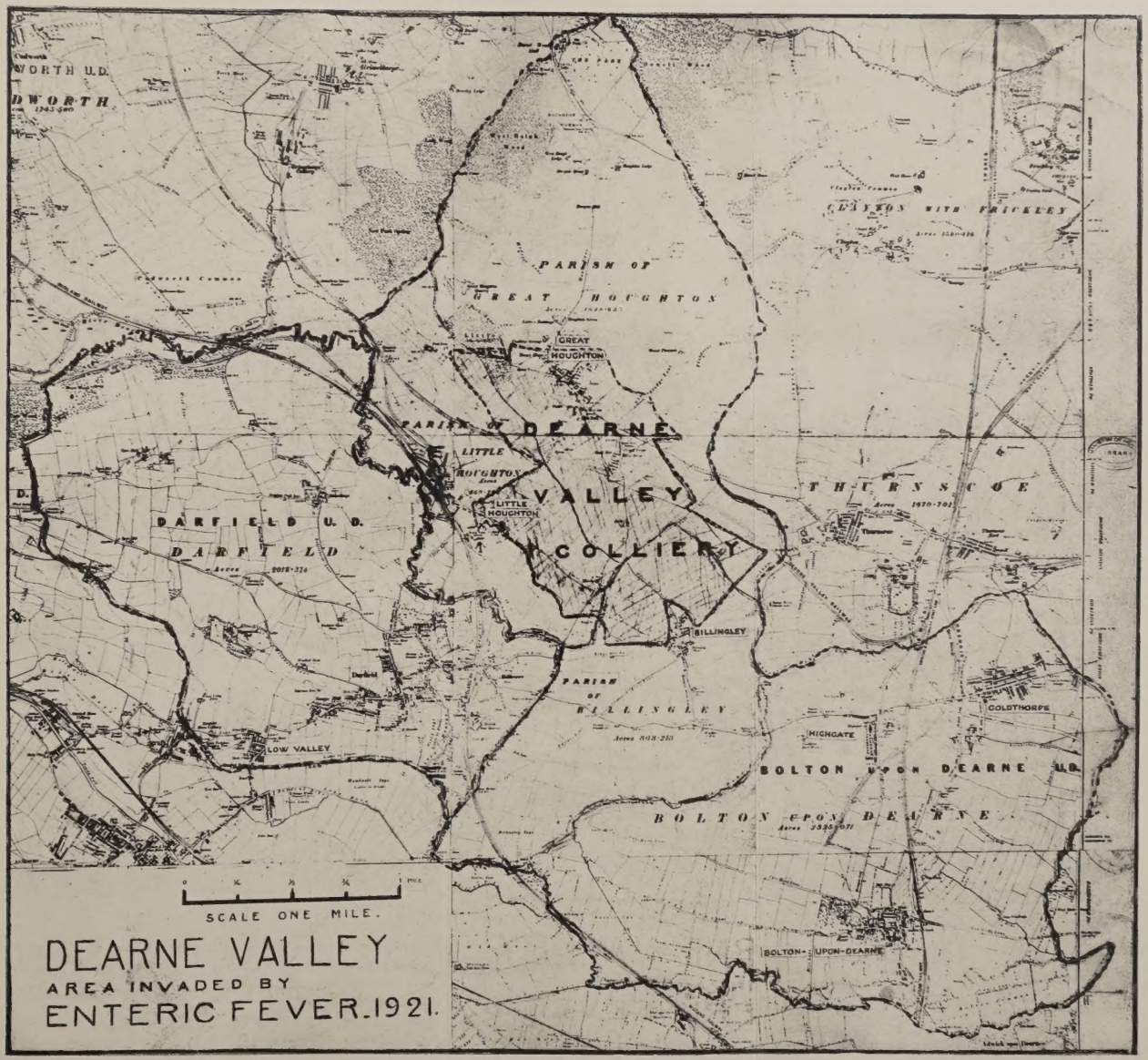
In regard to the second outbreak of Enteric Fever it is clear that at the time of its occurrence the specific infection of Enteric Fever was present and widely distributed in the district, that the public, *i.e.*, the " piped," water-supply was inadequate for the needs of the population of Bolton-upon-Dearne village which is situated at the extreme end of the water mains. The scanty supply of the " piped " water resulted in a large proportion of the inhabitants resorting to and relying on the public and local pumps for their daily supply of water. For this reason the population of the village in great measure escaped attack in the first outbreak, and it was directly responsible for the extraordinarily heavy incidence of attack which fell on the villagers in the second outbreak. Compared with the specific contamination of the piped supply, that of the public and local wells in the village must have been intense. The precise manner in which the local well water acquired the specific contamination can be only a matter of conjecture; the fact remains that the sources of, and opportunities for, pollution were many and various. It is evident that they may have been operative for many previous years and it was only when the specific infection of Enteric Fever was introduced that the catastrophe happened. It must be borne in mind that a similar occurrence may take place at any time should the water from these wells afford the principal, or indeed even a minor, source of water supply for domestic purposes.

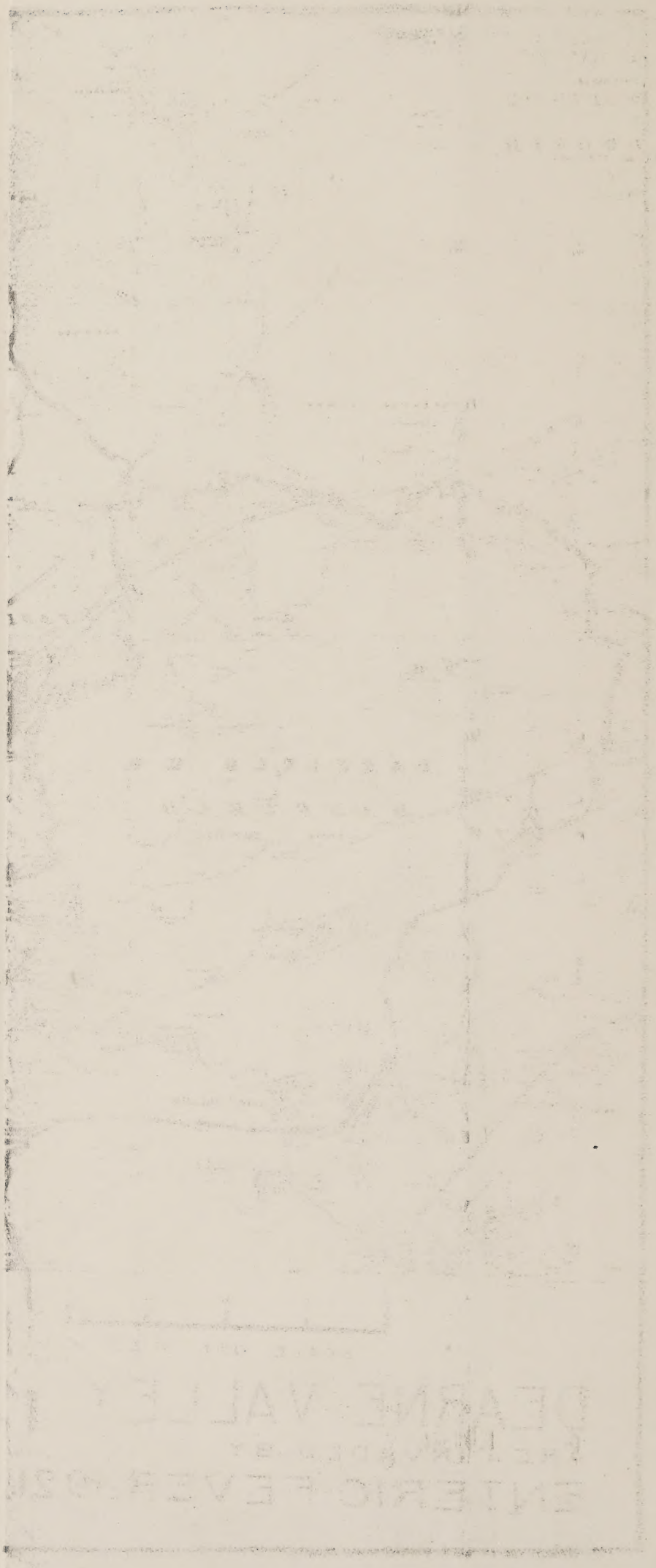
The local community has suffered severely in sickness and death from a disease which is preventable; it is the duty of the District Councils, who are the Sanitary Authorities responsible for the public health of the inhabitants of their districts, to take effective action to prevent a like recurrence.

I take this opportunity to acknowledge the ready help and assistance received during the course of my inquiry from the medical practitioners of the district, and the officials of the various Sanitary Authorities concerned.

W. V. Shaw.

Richard J. Reece,
Senior Medical Officer.
March 1922.


WORTH U.D.
DWORTH
PARISH OF
GREAT HOUGHTON
GREAT HOUGHTON
PARISH OF DEARNE
LITTLE HOUGHTON
LITTLE HOUGHTON
VALLEY
COLLIERY
DARFIELD U.D.
DARFIELD
THURNSCOE
BILLINGLEY
PARISH OF BILLINGLEY
GOLDTHORPE
HIGHGATE
LOW VALLEY
BOLTON UPON DEARNE U.D.
BOLTON UPON DEARNE
BOLTON-UPON-DEARNE
SCALE ONE MILE.
DEARNE VALLEY
AREA INVADED BY
ENTERIC FEVER. 1921.



APPENDIX I.

A.—COPIES OF REPORTS ON THE EXAMINATION OF SAMPLES OF WATER FROM THE DEARNE VALLEY COLLIERY SUPPLY OF THE DEARNE VALLEY WATER BOARD.

A specimen of this water was collected on 23rd August 1921 at the Colliery and examined at the Public Health Laboratory, Wakefield.

Sample 1.—"Report on the Bacteriological Examination of Water from Dearne Valley Colliery, Little Houghton, Hemsworth Rural District. Collected by County Sanitary Inspector, 23rd August 1921, at 2 p.m., for Bacteriological Examination."

"*Bacterial Content.*—Average number of organisms developing on gelatine plates incubated for 72 hours at room temperature—624 per c.c. of water. Average number of organisms developing on agar plates incubated for 72 hours at 37° C. = 375 per c.c. of water.

"*Coliform Organisms.*—Present in 0·1 c.c. of water. *B. enteritidis sporogenes.*—Not present in 5 or 10 c.c. of water. *Examination for B. typhosus.*—Cultures and sub-cultures gave a negative result. Streptococci were found in abundance in quantities of 5 and 10 c.c. of the water.

"This examination shows a certain amount of pollution and the presence of streptococci would make one suspicious of human excrement.

(Sgd.) A. W. FREW,
29th August1921."

The expert adviser of the Dearne Valley Water Board is Mr. John Evans, F.I.C., one of the firm Allen and Partners of 67, Surrey Street, Sheffield. He states that the Dearne Valley Water Board usually send him samples of water for chemical examination, collected by their manager; and that no details of time or place or method of collection of the sample are sent with them.

Sample 2.—Mr. Evans' report of 27th June 1921 on the Colliery water examined by him is as follows :—

"Public Analyst's Laboratory,
67, Surrey Street,
Sheffield,
27th June 1921.

"REPORT on a sample of water received from T. H. Good, Esq., Dearne Valley Water Board, Wombwell, on 9th June 1921.

"*Physical Characters.*

Suspended Matter	None.
Appearance of a column 2 ft. long	Clear; colourless.
Taste	Normal.
Odour	None.

"*Chemical Examination.*

	Parts per 100,000.
Total Solid Matter	120·8
Loss on ignition	17·8
Chlorine	14·57
Equivalent to Sodium Chloride	24·04
Nitrites	None.
Nitrates as Nitrogen	None.
Poisonous Metals (Lead, &c.)	None.
Total Hardness	53·6
Temporary Hardness	10·7
Permanent Hardness	42·9
Oxygen absorbed in three hours	0·022
Free Ammonia	0·024
Albuminoid Ammonia	0·006

" *Bacteriological Examination.*

MacConkey's Bile Salt Lactose Broth—	
with 1 c.c. of water	Negative.
with 10 c.c. of water	Negative.

" *Bacterial Content.*—

Average number of Organisms per c.c. developing on Gelatine Plates, incubated at 22°C. for 72 hours	6

Sample 3.—The next sample was sent to Mr. Evans on 2nd July 1921, and on 20th July he reported as follows :—

" Report on a sample of Water received from the Dearne Valley Water Board, Bolton-on-Dearne Urban District Council, Station Road, Bolton-on-Dearne, on 2nd July 1921."

" *Physical Characters.*

Suspended Matter	Heavy trace.
Appearance of a column 2 ft. long	Slightly cloudy, greyish.
Taste	Normal.
Odour	None.

" *Chemical Examination.*	*Parts per* 100,000.
Total Solid Matter	25·0
Loss on ignition	5·4
Chlorine	2·57
Equivalent to Sodium Chloride	4·23
Nitrites	None
Nitrates as Nitrogen	None
Poisonous Metals (Lead, &c.)	None
Total Hardness	20·0
Temporary Hardness	7·1
Permanent Hardness	12·9
Oxygen Absorbed in three hours	0·044
Free Ammonia	0·018
Albuminoid Ammonia	0·006

" *Remarks.*—These results show the water in its present condition to be free from other than normal traces of readily changeable Organic Matter and negative any suspicion of contamination by drainage or similar impurity. The water is of medium hardness, and in my opinion will be found a suitable source of supply for drinking and general domestic purposes.

20th July 1921."

Sample 4.—A sample of the Colliery water taken at Dearne Valley Colliery on 26th August, was examined chemically by Mr. Evans, who reported on 30th August 1921 :—

" Report on a sample of Water from T. H. Good, Esq., Dearne Valley Water Board, Bolton-on-Dearne, on 26th August 1921.

" *Mark.*—Water from Dearne Valley Colliery.

" *Physical Characters.*

Suspended Matter	Trace.
Appearance of a column 2 ft. long	Cloudy, faintly yellow.
Taste	Normal.
Odour	None.

" *Chemical Examination.* *Parts per* 100,000.

Total Solid Matter	48·36
Loss on ignition	5·22
Chlorine	3·66
Equivalent to Sodium Chloride	6·34
Nitrites	None
Nitrates as Nitrogen	Trace
Poisonous Metals (Lead, &c.)	None
Total Hardness	5·6
Oxygen Absorbed in three hours	0·000
Free Ammonia	0·002
Albuminoid Ammonia	0·0056

" *Remarks.*—The low figures recorded under the heads of Oxygen Absorbed, Free and Albuminoid Ammonia, show the water in its present condition to be free from other than normal traces of readily changeable Organic Matter and negative pollution.

" The water contains a fair amount of Mineral Matter in Solution but the hardness is low.

" The trace of Suspended Matter was found to be composed of Calcium Carbonate, evidently left in suspension after the softening treatment.

" The cloudiness of the water is also due to this Calcium Carbonate. The water is quite neutral to Litmus.

" In my opinion the water will be found a safe source of supply for drinking and general domestic purposes."
30th August 1921.

This report should be compared with the report on Sample 1 examined bacteriologically in the Public Health Laboratory of the West Riding County Council.

Sample 5.—A further sample was taken at Dearne Valley Colliery on 3rd October 1921. This was examined both chemically and bacteriologically by Mr. Evans of Sheffield, who reported on 13th October 1921 :—

" Report on a sample of Water received from J. Ledger Hawksworth, Esq., Dearne Valley Water Board, Bolton-on-Dearne, nr. Rotherham on 3rd October 1921.

" *Mark.*—Untreated Water, Dearne Valley Colliery.

" *Physical Characters.*

Suspended Matter	Trace.
Appearance of a column 2 ft. long	Clear; colourless.
Taste	Normal.
Odour	None.

" *Chemical Examination.* *Parts per* 100,000.

Total Solid Matter	51·20
Loss on ignition	7·80
Chlorine	4·14
Equivalent to Sodium Chloride	6·83
Nitrites	None
Nitrates as Nitrogen	Trace
Poisonous Metals (Lead, &c.)	None
Total Hardness	4·6
Oxygen Absorbed in three hours	0·013
Free Ammonia	0·000
Albuminoid Ammonia	0·004

"*Bacteriological Examination.*

B. Coli Communis.

MacConkey's Bile Salt Lactose Broth—

with 1 c.c. of water	Negative.
,, 10 ,, ,,	,,
,, 100 ,, ,,	Positive.
Neutral Red Broth with 1 c.c. of Water	Negative.

B. Enteritidis Sporogenes.

Litmus Milk (incubated anærobically).

with 1 c.c. of water	Negative.
,, 10 ,, ,,	,,

"The earthy and saline matters in solution were chiefly composed as follows :—

——	Grains per Gallon.	Parts per 100,000.
Silica	0·63	0·90
Alumina and Iron Oxide	0·28	0·40
Calcium Carbonate	1·75	2·50
Magnesium Carbonate	1·74	2·49
Sodium Carbonate	15·80	22·57
Sodium Chloride	4·78	6·83
Sodium Sulphate	10·19	14·56
	35·17	50·25

13th October 1921."

Four samples were taken in different parts of the area supplied from Dearne Valley Colliery on 3rd November, and Mr. Evans' reports on them, dated 17th November, are as follows :—

"*Sample* 6 (*a*). *Mark.*—From No. 1 Barnsley Road, Highgate, November 3rd, 1921.

"*Physical Characters.*

Suspended Matter	None.
Appearance of a column 2 ft. long	Clear; colourless.
Taste	Normal.
Odour	None.

"*Chemical Examination.*

	Parts per 100,000.
Total Solid Matter	53·2
Loss on ignition	8·4
Chlorine	5·57
Equivalent to Sodium Chloride	9·17
Nitrites	None.
Nitrates as Nitrogen	Faint Trace.
Poisonous Metals (Lead, etc.)	None.
Total Hardness	11·4
Oxygen absorbed in three hours	0·000
Free Ammonia	0·0005
Albuminoid Ammonia	0·002

"*Remarks.*—The low figures recorded under the heads of Oxygen Absorbed, Free and Albuminoid Ammonia, together with the absence of Nitrites, and only a faint indication of Nitrates, negative pollution.

17th November 1921."

"*Sample* 6(*b*).—Report on a sample of Water received from the Dearne Valley Water Board, Bolton-on-Dearne, on 3rd November 1921.

"*Mark.*—From No. 37, Wath Road, Bolton-on-Dearne."

"*Physical Characters.*—

Suspended Matter	Trace.
Appearance of a column 2 ft. long	Clear; colourless.
Taste	Normal.
Odour	None.

"*Chemical Examination.*

	Parts per 100,000.
Total Solid Matter	47·80
Loss on ignition	6·00
Chlorine	4·14
Equivalent to Sodium Chloride	6·83
Nitrites	None.
Nitrates as Nitrogen	Trace.
Poisonous Metals (Lead, &c.)	None.
Total Hardness	5·7
Oxygen Absorbed in three hours	0·000
Free Ammonia	0·0005
Albuminoid Ammonia	0·002

"*Remarks.*—The low figures recorded under the heads of Oxygen Absorbed, Free and Albuminoid Ammonia, together with the absence of Nitrites, and only a faint indication of Nitrates, negative pollution.

"17th November, 1921."

"*Sample* 6 (*c*).—Report on a sample of Water from the Dearne Valley Water Board, Bolton-on-Dearne, on November 3rd, 1921.

"*Mark.*—From Field House, off Snape Hill Road, Darfield.

"*Physical Characters.*—

Suspended Matter	Trace.
Appearance of a column 2ft. long	Slightly cloudy; colourless.
Taste	Normal.
Odour	None.

"*Chemical Examination.*

	Parts per 100,000.
Total Solid Matter	100·8
Loss on ignition	14·6
Chlorine	16·86
Equivalent to Sodium Chloride	27·81
Nitrites	None.
Nitrates as Nitrogen	Faint trace.
Poisonous Metals (Lead, &c.)	None.
Total Hardness	42·8
Oxygen Absorbed in three hours	0·007
Free Ammonia	0·004
Albuminoid Ammonia	0·002

"*Remarks.*—The Chlorine figure is abnormally high, but the other figures are normal. I cannot account for this high Chlorine figure.

"17th November 1921."

"*Sample* 6(*d*).—Report on a sample of Water received from the Dearne Valley Water Board, Bolton-on-Dearne, on 3rd November 1921.

"*Mark.*—"Sandhill Club, Great Houghton. 3rd November 1921.

"*Physical Characters.*

Suspended Matter	None.
Appearance of a column of 2 ft. long	Clear; colourless.
Taste	Normal.
Odour	None.

" *Chemical Examination.*	*Parts per* 100,000.
Total Solid Matter	50·6
Loss on ignition	5·6
Chlorine	5·29
Equivalent to Sodium Chloride	8·70
Nitrites	None.
Nitrates as Nitrogen	Trace.
Poisonous Metals (Lead, &c.)	None.
Total Hardness	8·6
Oxygen Absorbed in three hours	0·004
Free Ammonia	0·0005
Albuminoid Ammonia	0·002

" *Remarks.*—The low figures recorded under the heads of Oxygen Absorbed, Free and Albuminoid Ammonia, together with the absence of Nitrites and only a faint trace of Nitrates, negative pollution.

" 17th November 1921."

A sample of water from the Colliery supply was taken on 15th November and examined at the Public Health Laboratory of the County Council with the following result :—

" *Sample* 7.—Report on the Bacteriological Examination of Water collected at end of Rising Main from Dearne Valley Colliery, 15th November 1921, by Mr. Holmes, County Sanitary Inspector.

" *Bacterial Content.*—Average number of organisms developing on gelatine plates incubated for 3 days at room temperature = 155 per c.c. of water.

" Average number of organisms developing on agar plates incubated for 3 days at 37° C. = 76 per c.c. of water.

" *B. coli.*—Present in 5 c.c. but not in 1 c.c. of water.

" *B. enteritidis sporogenes.*—Not present in 5 or 10 c.c. of water.

" The above result fails to show evidence of contamination of the water. There has been a marked improvement in the condition of this water since the last examination.

" (Sgd) P. L. SUTHERLAND."

" 21st November 1921."

B.—COPIES OF REPORTS ON THE EXAMINATION OF WATER FROM THE PUBLIC PUMP IN HIGH STREET, BOLTON-UPON-DEARNE VILLAGE AND OTHER LOCAL WELLS.

Sample 1.—" Report on the bacteriological examination of water collected at the Public Pump, High Street, Bolton-upon-Dearne by Dr. Lawrence, received 2nd November 1921.

" *Bacterial Content.*—Average number of organisms developing on gelatine plates incubated for three days at room temperature = 113 per c.c. of water. Average number of organisms developing on agar plates incubated for three days at 37° C = 104 per c.c. of water.

" *Coliform organisms.*—Present in 0·1 c.c. of water.

" *B. enteritidis sporogenes.*—Present in 10 c.c. of water, but not in 5 c.c.

" The above examination shows that the water is polluted.

(Signed) P. L. SUTHERLAND."

" 7th November 1921."

Sample 2.—" Report on the bacteriological examination of water collected at 46, High Street, Bolton-on-Dearne, on the 16th November 1921, by Dr. Lawrence.

" *Bacterial Content.*—Average number of organisms developing on gelatine plates incubated for three days at room temperature = 88 per c.c. of water. Average number of organisms developing on agar plates incubated for three days at 37° C. = 10 per c.c. of water.

" *B. Coli.*—Present in 10 but not in 5 c.c. of water.

" *B. enteritidis sporogenes.*—Present in 5 c.c. of water.

" Although this water has a low bacterial content and B. coli is not present in quantities below 10 c.c., there is a suspicion of pollution as B. enteritidis sporogenes is present in 5 c.c.

(Signed) P. L. SUTHERLAND."

" 22nd November 1921."

Sample 3.—" Report on the bacteriological examination of water collected at 12, Willow Lane, Bolton-upon-Dearne, on the 16th November 1921, by Dr. Lawrence.

" *Bacterial Content.*—Average number of organisms developing on gelatine plates incubated for 3 days at room temperature = 1,300 per c.c. of water. Average number of organisms developing on agar plates incubated for 3 days at 37° C. = 93 per c.c. of water.

" *B. Coli.*—Present in 1 c.c. but not in 0·1 c.c. of water.

" *B. enteritidis sporogenes.*—Not present in 5 or 10 cc. of water.

" The above examination shows that this water is polluted.

(Signed) P. L. SUTHERLAND."

" 22nd November 1921."

Sample 4.—" Report on the bacteriological examination of water collected at No. 7, Thurnscoe Road, by Mr. Holmes, County Sanitary Inspector, on the 22nd November 1921.

" *Bacterial Content.*—Average number of organisms developing on gelatine plates incubated for three days at room temperature = 232 per c.c. of water. Average number of organisms developing on agar plates incubated for three days at 37° C. = 70 per c.c. of water.

" *B. Coli.*—Present in 0·1 c.c. but not in 0·01 c.c. of water.

" *B. enteritidis sporogenes.*—Not present in 10 or 5 c.c. of water. *Typical streptococci* in 10 c.c. but not in 5 c.c.

" The above examination shows that the water is polluted.

(Signed) P. L. SUTHERLAND."

" 28th November 1921."

Sample 5.—" Report on the bacteriological examination of water collected at 67, High Street, (Lockwood Farm) on the 23rd November 1921, by Dr. Lawrence.

" *Bacterial Content.*—Average number of organisms developing on gelatine plates incubated for three days at room temperature = 2,200 per c.c. of water. Average number of organisms developing on agar plates incubated for 3 days at 37° C. = 215 per c.c. of water.

" *B. Coli.*—Present in 0·1 but not in 0·01 per c.c.

" *B. enteritidis sporogenes.*—Not present in 10 or 5 c.c. of water.

" The examination shows that this water is polluted.

(Signed) P. L. SUTHERLAND."

" 29th November 1921."

APPENDIX II.

GENERAL SANITARY CIRCUMSTANCES AND ADMINISTRATION OF THE DISTRICTS INVADED BY ENTERIC FEVER.

BOLTON-UPON-DEARNE URBAN DISTRICT.

The Urban District Council consists of twelve members, and a committee of seven meets as the Sanitary Committee once a month in the week preceding the meeting of the Council.

The Medical Officer of Health.—Dr. J. M. Lawl, who was Medical Officer of Health when the outbreak occurred, resigned this appointment; and on 13th September 1921, Dr. James K. W. Morris, M.B., Ch.B., was appointed as his successor. Dr. Morris receives a salary of 80*l.* per annum as Medical Officer of Health, he is in general practice in the district and resides at Goldthorpe.

The Sanitary Inspector.—This office is held by Mr. G. H. Bates, who holds the certificate of the Royal Sanitary Institute, and a similar certificate and the Meat Inspector's Certificate of the Victoria University of Manchester. He also acts as Superintendent of Scavenging and is the designated officer of the Bolton-upon-Dearne Housing Scheme, and he superintends the disinfection of premises. During the outbreak he rendered very valuable service. His salary as Sanitary Inspector is 290*l.* per annum and as Superintendent of Scavenging 10*l.* per annum.

Health Visitor.—This office is held by Miss Lydia Gopsill, a trained nurse, who is chiefly concerned with Maternity and Child Welfare work. On the outbreak of Enteric Fever she did very useful work in visiting invaded houses, in giving advice and assistance in cases of illness, and in obtaining information in regard to sickness in houses. She receives a salary of 197*l.* 14*s.* 4*d.* per annum.

Sewerage and Sewage Disposal.—There is a separate sewerage system for the village of Bolton-upon-Dearne, and the villages of Goldthorpe and Highgate, though all the sewage is treated at a common outfall. Throughout the Urban District of Bolton-upon-Dearne the sewage and surface water pass by the same system of pipes to the Sewage Works.

Highgate and Goldthorpe sewers all empty into the head of an eight-inch syphon, which is constructed of cast iron pipes jointed in lead. When this syphon is overcharged, it overflows into a gravitation sewer at a lower level in the same trench which carries the sewage from Goldthorpe (Pinfold) to the outfall works. This gravitation sewer also takes sewage from Bolton-upon-Dearne village north of the cemetery to the outfall. All Bolton village sewage from south of the cemetery gravitates in other sewers to the sewage works. These outfall sewage works lie to the south-east of Bolton-upon-Dearne and east of the Midland and North Eastern Joint Railway line.

The gravitation sewers are earthenware pipes where they can be laid in trenches cut in the rock, but in water-logged loose ground, *e.g.*, on the site of the outfall works iron pipes jointed with lead are substituted. There are no brick built sewers. No house drains are connected direct to syphon sewers.

In Goldthorpe, I am informed by Mr. J. W. Wilson, Surveyor to the Bolton-upon-Dearne Urban District Council, subsidence took place along the course of the sewers, some ten years ago. But subsequently further settling of the superficial strata took place, and this restored the alignment of the sewer. The sewer remained watertight throughout.

In Bolton-upon-Dearne village the main gravitation sewer runs eastwards from the junction of Thurnscoe Road, Wath Road and High Street along High Street to the outfall works. It is laid in the rock, and has

recently been inspected at the manholes and found to be in good condition. All the houses in Bolton-upon-Dearne village west and south of this sewer empty their sewage into sewers south of the High Street sewer. These are new sewers laid subsequent to the High Street sewer and not connected with it, though they likewise convey sewage by gravitation to the outfall works.

Sewage conveyed by the gravitation sewers has to be pumped up to the level of the tanks at the sewage works, but the syphon from Goldthorpe and Highgate delivers sewage on to the level of the tanks.

The level of the invert of the drainage system of Bolton-upon-Dearne Urban District at the outfall works is 53·08 feet O.D., and the sewage tanks are 60·88 feet O.D.

The sewage enters into screening chambers, where the grosser material is retained and subsequently raked out. Sewage then falls into a Dortmund tank from which it is received into a septic tank, and afterwards in a dosing chamber which allows a certain quantity to empty on to the filters at each discharge—the filters rest awhile between each dose. The effluent from the filters is clear, but before being discharged into the River Dearne it passes through a humus tank.

Excrement and Refuse Disposal.—In no part of the Bolton-upon-Dearne Urban District is the water carriage system the only, or indeed the chief, means of excrement disposal. For various reasons, among which the insufficient supply of water is one of importance, the water carriage system has not superseded the conservancy methods. Further, there are water closets in the district not provided with flushing tanks, and which are hand flushed, usually with slops and waste water. The following tabular statement shows the proportion of water closets and midden privies in different parts of the Urban District :—

Type of Sanitary Convenience.	Villages of :—			Total.
	Bolton-upon-Dearne.	Highgate.	Goldthorpe	
Water closets provided with flushing tanks - - -	280	76	938	1,294
Hand-flushed closets - -	9	9	66	84
Privies - - - - -	463	109	407	979

Throughout the district the majority of the middens receive excrement from more than one privy, the number of privies and middens is shown in the following table :—

——	Bolton-upon-Dearne.	Highgate.	Goldthorpe	Total.
With one privy to one midden	56	13	50	119
,, 2 privies ,, ,,	143	48	173	364
,, 3 ,, ,, ,,	7	—	1	8
,, 4 ,, ,, ,,	22	—	2	24
,, 5 ,, ,, ,,	1	—	—	1
,, 6 ,, ,, ,,	—	—	—	—
,, 7 ,, ,, ,,	1	—	—	1

These middens are scavenged once a month and the work is done during the night. The midden contents are removed in buckets and tipped into the scavenging cart, and conveyed from Highgate and Goldthorpe to tips at "The Marsh," Barnbrough Lane, Goldthorpe, but from Bolton-upon-Dearne village the material is deposited on land at the sewage outfall works. The scavenging work is carried out by the staff of the District Council, 8 men and 4 horses and carts being employed. The type of cart is an open waggon with folding tarpaulins, and is not entirely satisfactory.

In addition to the middens connected with privies house refuse is deposited in galvanised iron dustbins, and ashpits. The dustbins are emptied weekly and the dry ashpits monthly. The distribution of these receptacles in the district is shown in the following table :—

——	Bolton-upon-Dearne.	Highgate.	Goldthorpe	Total.
Galvanised iron pails, &c. -	278	78	879	1,235
Fixed ashpits - - -	13	2	155	170
Middens - - - -	463	109	437	1,009

Bolton-upon-Dearne, the oldest village, has a considerably higher proportion of middens as a common receptacle for excrement or house refuse. In the summer of the year 1921 there was a shortage of coal fuel, and in consequence a relatively small proportion of ashes mixed with the excrement and vegetable matter in these middens.

House refuse is taken to the tip at "The Marsh," Barnbrough Lane, Goldthorpe, but some of it is used for making up accommodation roads. Bolton-upon-Dearne Urban District is now almost entirely dependent upon the tips at "The Marsh," Barnbrough Lane, for the disposal of refuse. Here the tips have attained considerable proportions and serious complaint has been made as to offensive smells and the multitude of flies breeding in the uncovered refuse. The refuse has been spread broadcast and no attempt has been made to cover it with soil. All available land at the sewage works will soon have been utilised for the disposal of midden contents from Bolton-upon-Dearne village. There is very little arable land in the neighbourhood, even if arrangements could be made to use it for sewage disposal. Some attempt should be made by the local Sanitary Authority to introduce a system of tipping and covering at "The Marsh," Barnbrough Lane, to enable the site to be used to the best advantage for the disposal of excrement and house refuse.

Highgate.—When once the infection of enteric fever is introduced in a colliery village having leaky midden privies, backyards used in common by several households, undrained and unpaved back streets, there are ample facilities for it to become established. These conditions existed in the village of Highgate, where secondary cases of Enteric Fever were occurring down to December 1921.

The village with a population of 1029 persons forms roughly a parallelogram with long axis lying north and south. The north end is at an elevation of 160 feet O.D. and the south end 110 feet O.D. There is thus a fall of 50 feet in about 350 yards, and this is most marked between William Street and Edward Road which both run east and west. Running north and south, between George Street and Bolton Road, and parallel to them, is an alley-way, giving access to the backyards of the houses, and having midden privies on the east side for its whole length, but on the west side only at its upper end; the lower 14 houses have water closets. The lane is concreted, but the unpaved backyards are sometimes common to at least two premises.

The backyards and midden privies of premises at the upper end of George Street and Bolton Road (Highgate Lane) are terraced one above another. From the slope of the ground there is no hindrance to liquid filth from the middens at the upper end on higher ground flowing or soaking down the slope to contaminate ground on the lower level; and this is facilitated by the nature of the ground and sub-soil which here is sandy, and sandstone rag having immediately beneath it an impervious layer of blue clay. The surface soil is quickly saturated, and at the lower end of Highgate running water comes to the surface with the outcrop of the blue clay.

There are no wells, or pumps drawing water from surface wells, in Highgate.

The onset of the illness in the first known cases of Enteric Fever at Highgate occurred on 24th July 1921, and one of these was not removed to Hospital until 12th August. Altogether to 24th December there were 36 recognised cases of Enteric Fever in the village. Six houses in George Street, nine in Bolton Road, and one in Edward Street were invaded Multiple cases in houses were frequent, *e.g.*, seven in one and six in another.

DARFIELD URBAN DISTRICT.

The Urban District Council consists of ten members, and a Sanitary Committee of this Council meets every fourth Tuesday.

The Medical Officer of Health.—This office is held by Dr. R. F. Castle, M.B., B.C. Cantab., M.R.C.S.Eng., who resides at Darfield. He is in general practice in the district, and as medical officer of health he receives a salary of 35*l.* per annum.

The Sanitary Inspector.—Mr. E. Hammerton, who holds the certificate of the Royal Sanitary Institute, is the sanitary inspector for this district. He receives a salary of 180*l.* per annum. He also holds the office of surveyor to the Darfield Urban District Council and he acts as superintendent of scavenging.

Sewerage and Sewage Disposal.—With the exception of outlying farms the whole of the urban district is sewered. These sewers are constructed of salt glazed earthenware pipes with cement joints, and are said to be sound and in good working order. They deliver the sewage to outfall works. The outfall works have septic tanks, from which the sewage passes on to primary and secondary filter beds—the effluent from the filters runs into a final humus tank before discharging into the River Dearne. Samples have been taken of the effluent at regular intervals by the West Riding Rivers Board, who report the results of treatment as good.

Excrement and Refuse Disposal.—There are 589 privies to 351 middens, 100 hand-flushed water-closets, 101 water-closets provided with flushing tanks, 6 pail-closets for excrement, and 43 fixed ash-pits, and 95 galvanised iron pails or other movable receptacles for house refuse. It will be seen that the privies outnumber the water-closets considerably.

The scavenging is done by the staff of the District Council, viz., two horses and carts, with drivers and one ash-pit man permanently. One horse and cart, with driver and assistant on house refuse collection, and assisting in cleaning middens as required, three days a week.

About 20 per cent. of the midden contents are taken to outlying farms and disposed of on arable land. The remainder is taken to the Council's tip in Low Valley. House refuse is all taken to the tip.

Roads and Yards.—The streets of Darfield are made the receptacle for too much loose refuse—dirty paper, battered tin cans and broken glass.

HEMSWORTH RURAL DISTRICT.

The parishes of Great and Little Houghton are a part of Hemsworth Rural District.

The Medical Officer of Health.—This office is held by Dr. Ross Gardner of Hemsworth. He is in general practice in the district and receives a salary of 112*l.* 10*s.* per annum as Medical Officer of Health.

Sanitary Inspectors.—There are two Sanitary Inspectors for Hemsworth Rural District, who are paid a salary of 250*l.* (plus bonus) each. The senior inspector is Mr. T. S. Finn, who is a member of the Royal Sanitary Institute.

Sewerage and Sewage Disposal.—Only a part of the parishes of Great and Little Houghton have any sewers. Such sewers as there are take sewage to the Hemsworth Rural District sewage works which lie between Little Houghton and Darfield.

BARNSLEY RURAL DISTRICT.

The parish of Billingley is in Barnsley Rural District.

The Medical Officer of Health.—This office is held by Dr. F. J. Sadler. He resides at Barnsley, where he is in general practice. As Medical Officer of Health he is paid a salary of 55*l.* per annum.

The Sanitary Inspector.—This office is held by Mr. D. Thompson, for which he receives a salary of 135*l.* per annum. He also acts as Highways Surveyor, for which he is paid 95*l.* per annum.

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